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How climate and agriculture fares with food security in Pakistan?

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Abstract. In this paper we measure all the components of food security. The objective of the study is tomeasure the impact of Area under cultivation, Mechanical inputs, and Average Rainfall (mm per year) on food security index. Auto-regressive distributed lagged model (ARDL) is used in both models. In model 1 the data is from 1990-2014 and in model 2 the data is from 1973-2014. On the basis of our analysis we suggest that agricultural factors are significantly affecting the food production in case of Pakistan.
Keywords. Food security index, Food production index, FIMI, ARDL.
JEL. F60, F63, F66.

1. Introduction

Food security is a concept oriented in the mid of 1970s since then food security concept was familiarized. Now the issue related to food insecurity has been very serious in the world including Pakistan but unfortunately Pakistan has not done any consideration over food security. According to Food and Agriculture Organization (FAO) of the United Nations (2009), when households' caloric intake goes below the minimum dietary energy requirement malnourishment exists (FAO, 2010). The world food production has doubled during the past three decades whereas the number of malnourished people is soaring above 900 million around the globe. Pinstrup-Andersen (2009) defines that the word food security means having sufficient quantity of food at national and individual level.

There are multiple definition of food security, According to (Maxwell & Smith, 1992) round about two hundred definitions of food security have been developed and then considering the issue of food security from inventive fact. However, the most comprehensive definition, of food security comes from FAO (2010) "food security exists when all people, at all times, have physical, social and economic access to sufficient, safe and nutritious food that meets their dietary needs and food preferences for an active and healthy life." Food security contains four components food availability, access, utilization and stability. When the supply of food in the country covers the food stuff demand of its growing population that situation is called food security in a country.

On contrary, food insecurity is known to be the absence of any of the conditions stated in the above description about food security at any level i.e. household, regional and national level. When individuals continuously take insufficient amounts of food to meet their daily dietary energy needs it is considered as severe food insecurity. This severe food insecurity may lead to hunger, the most severe stage of food insecurity (FAO, 2010). Hunger can also

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regarded as food insecurity situation, which is defined by different authors in literature differently. Food security has been checked at different stages like national, international, individual or household over the period of time but one stage of food security cannot measure the assurance of other stage Maxwell & Smith, (1996), Clay (2002).

Food security problem is receiving more consideration by the world nowadays. Although, Pakistan is able to produce food for their growing population but still there is deficiency of food stock for domestic needs. Scarcity in food production is a general thing in Pakistan due to some economic, climatic, infrastructure and technological reasons. To meet the deficiency in food stuff, our government should import food and increase the food prices. The government has been actively following the policies of support pricing, storage and allocation still even the basic necessity edibles are available at a very high cost. Food security is an important factor which is generally ignored (Fullbrook, 2010). Pinstrup-Andersen (2009) explored that a country which has no power and resources to produce the desired food stuff or not having enough money to import food from international markets is called food sovereign state.

In order to improve food security of urban and rural population is by enhancing agriculture productivity in Pakistan as agriculture sector is the back bone of Pakistan. There are many economic, climatic and infrastructure factors that affects food security in Pakistan. The most important factor is growing population. Total area under cultivation has decreased due to the increase in population. The current rate of population growth is considered a bit too high and it is anticipated to be twice the number by 2050 which is likely to make the Pakistan the fourth largest country among the six most populous nations of the world. Attaining the aim of nourishment safety particularly for meager populace becomes problematic outcome of weather variation (Gregory *et al.,* 2005).

According to Malthus (1992) increases in population growth also increase the pressure on agricultural possessions and this burden can reduce agricultural efficiency and food production. Kumar & Sharma (2013) analyzed 13 major agricultural states of India show the impact of climate change on food security index from the period of 1985 to 2009.They also showed the relationship of food security index with Socio economic factors and other non-climatic factors such as gross sown area, irrigated area, agricultural labor, tractors, and government expenditures on agricultural and related activities. Their results show that in different Indian states climatic change badly affected food security index.

Timmer (2004) defines that it is an essential requirement of economic development to overcome food insecurity and poverty concern. Food security and financial growth both support each other in developing process. To indemnify food security of the country facing different challenges postured by climate change such as augmented unpredictability of rains temperature strain on garners and livestock etc. in planning and applying suitable edition procedures in the separate areas. Food security is a main apprehension in developing countries because the livelihood of a large number of populations in rural areas is depends on agriculture sector this make it an important sector in any economy. For both the developed and developing countries food insecurity is an important matter which unfortunately is generally ignored. However, the situation in developing countries is ever deteriorating. According to figure1 805 million undernourished people live in developing countries out of the total 805 million undernourished people of the world. In Asia and Africa the situation is getting even worse where 780 million undernourished people abide. In the given figure share of undernourished people in the year of 1990-92 shows the starvation in the world and this is the share of undernourished people in the era1990-92 and 1012-14 and changing the number of malnutrition in the world and share of undernourished people by the region 1990-92 and 2012-14 (FAO, 2014).

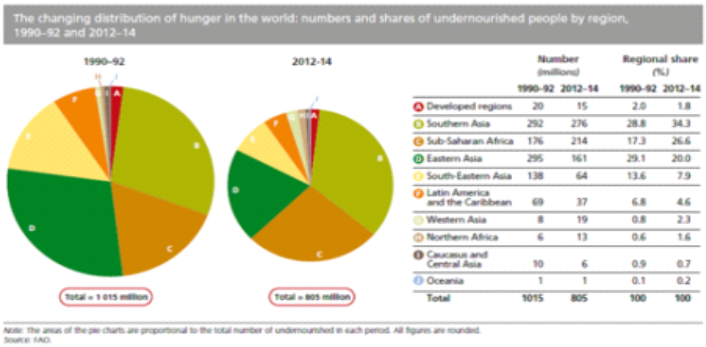


Figure1. *The changing distribution of hunger in the world Number and share of undernourished by region, 1990-92 and 2012-14.*
Source: FAO, 2014.

The study of Farquhar (2011) shows that the prices of major food items have increased to record levels consequently at start of 2011. Khan & Schimmel pfennig (2006) checked the causes and consequence of rising prices in Pakistan by economic and supply characteristic. In the long run along with medium run wheat charges influences the inflation in Pakistan and there is a long-run association with Consumer price index and private sector credit. According to the World Bank report (2012) Pakistan's economy is the 26th biggest economy of the world and agriculture sector is one of the world's most important producers of main agricultural commodities (FAO, 2011a) but the percentage of the hungry population is 26% that is more than high (FAO, 2011b).

Increases in food prices have made it difficult for the poor population of developing countries to get sufficient food. High food prices are challenge for the poor because they have to spend a large part of their income on food items. Hanif (2012) states that during the last two years Pakistan most horribly hit by the worldwide foodstuff inflation in 2008 pursued by the shocking down pours in 2010 and rainfall in 2011. All such inequities affected the food price which is chiefly connected to unpreserved foodstuff substance. Food security is strongly interlinked with the issues such as rising prices, international environment and climate changes, water, energy crisis and agriculture growth (Gustafson 2013, Hanumankar 2014). According to (Ahmad *et al.*, 2011) any inconsistency in climate change issues can directly affect a country's ability to nourish her population that's the reason climatic variation and food security are directly related to each other.

This particular study aims at clarifying food security and its determinants and also investigate the factors that influence food security and food production in Pakistan from the period 1973-2014. This study depicts the awareness about food security and food insecurity situation in Pakistan. Most of the literature is on the household determinants of food security not discussing food security at national level this study also fill this literature gap. On the other hand we focus on the four pillars of food security access, availability, utilization and stability. These food security indicators will be explained by different economic, climatic and agriculture input variables. This research also provides the descriptive method to create food security index and also provide food security index of Pakistan. In this study we used annual data of Pakistan over the 1990-2014 periods.

2. Literature review and theoretical background

Theoretically this study was based on Amartya Sen's theory of scarcity (Sen, 1981) defines all approaches of food security theoretically and measure food security. According to Sen Deficiencies occur not because there is not enough food, but because people do not have access to enough food. Of course, the availability of food near to the household is a requirement of food security. Availability of food is affected by different issues such as a community's proximity

to centers of production and supply, or by market forces, restrictions on trade and international policies that affect food supplies. Stability is about secure of food all the time. This includes times of natural shock like floods and droughts, and focuses specifically on the continuity of supply and demand of food grain product. Utilization of food refers to food safety, quality, and nutrition. All of these are keys to food-security analysis. Sen's work was however a fundamental advance before him, the availability of food was supposed to be the dominant determinant of famine. According to (Sen, 1981), people's 'exchange entitlements' (or their livelihood sources) reflect their ability to acquire food.

On the basis of food production it's right of the people to explain their particular strategies and plans for the defensible production, consumption and supply of food which assure the right to food for the whole population. By the world wide announcement of human right in 1948 food security is the right to food and it was acknowledged as a central component of standard of living. According to a survey almost 450 indicators and 200 definitions are available in existing literature. Pinstrup-Andersen (2009) explains that the term "food security" states the access to sufficient food that fulfils the desired amount of food. It also defines that when a country achieves stability between demand and supply by the production of food domestically then they said country is independent in food production. But in a developing country majority of the population cannot reach this situation because the focus of national and global food security is generally on the supply side.

The other dimension of food is availability of food but it cannot guarantee the access of food to the people. To ensure food security at the household or individual level all aspects of food security needs to be addressed. World Food Summit in 1996 redefined food security as 'food security exists when all people, at all times, have physical and economic access to sufficient safe and nutritious food to meet their dietary needs and food preferences for a healthy and active life'. In the above definition there are the four facets of food that are access, utilization, stability and availability of food. These four aspects are prejudiced by economic, political, physical and social situations inside the societies and also weakened by sudden shocks such as natural calamities and wars.

2.1. Theoretical framework of food security index

The concept of food security was firstly defined in 1948 by the acceptance of the United Nations Universal Declaration of Human Rights. In the world food discussion in 1974 the concept of food security was just availability of food and it was measured to be the single factor of food security. According to the World Bank in 1986, food security is defined as Access of food by all people at all time for healthy life. In this definition of food security availability and accessibility considered the components of food security. FAO 1996, defined food security as "Food security exists when all people at all times have physical or economic access to sufficient safe and nutritious food to meet their dietary needs and food preferences for an active and healthy life" (FAO, 1996). In this definition discuss three components of food security that are access, availability and utilization of food during Rome declaration on World Food Security in 2002. Finally, Food Agriculture Organization FAO clarified the meaning of food security as: "all people, at all times, have physical, social and economic access to sufficient, safe and nutritious food that meets their dietary needs and food preferences for an active and healthy life." In this definition food security contains four components of food security as we discussed (ADB, 2012; Kumar & Sharma, 2013). Now we may discuss the four dimensions of food security one by one for more clearance about food security.

The above conversation covered different extents of food security like availability, stability, accessibility and utilization of food position and their preferences. Generally in Pakistan achieving food security is very difficult and complex statistic. It's a challenging phenomenon in Pakistan. According to

Fullbrook (2010) the flow in food prices and strategy changes in various countries flashed off insecurity. Established nations think of "whether their own food security is in peril". Furthermore, the countries lacking food production not fulfill their food needs and also they are food insecure countries. The attentions of the world are largely restricted to promising stable stock of inexpensive healthy nutrition. The absence of the important problem of 'food security' is essentially vitality for people deprived of which "we are all dead" and thus should be regarded as a "security good" Fullbrook (2010).

Population growth will decrease the food security because it leads to decrease the availability of food. This decrease is intensified by problems of access and utilization of foodstuffs (Ehrlich & Ehrlich 1991; Ophuls & Boyan, 1992). Therefore, sustainable methods of food production and economic development are essential. Boko *et al.,* (2007) studied that the increase in population growth and inflation will negatively effect on food security. However, the increase in GDP per capita has positively affected on food security.

According to the author Malthus in (1992), population growth is a burden on agriculture sector and it can also reduce the food production and agriculture sector productivity. But according to some other author's population growth is not a problem to food security because it can reassure mechanical development as well as increase in productivity.

Felix & Kinda (2009) use two indicators of food security food production and undernourishment. They used panel data from the period of 1960 to 2008 and apply modern econometric technique for estimation. Firstly, they find that rainfall is a food insecurity factor in developing countries because instability in rainfall reduces the food production and increases the number of undernourished people. Secondly, they find that some regions of African countries are badly affected by rainfall uncertainty.

Boserup used different kinds of techniques and strategies for land usage and its enlargement to elaborate the issues of over population in developing countries. For the determination of relationship between security of food and increasing rate of population growth many writers used to justify socio economic factors by applying different technologies. Cohen (2008) disclose the ways to show economical and dogmatic tricks to minimize the risk of anxiety of food by using technologies that are responsible for the better source and yield of food.

Bashir, Pandit & Schilizzil (2013) investigate the provincial compassion of food security at household level in three districts of Punjab Pakistan, by using the primary data of 1152 households which are located in 12 districts in those regions used. They found that food insecurity was 31% which is highest in Central region of the sample households as compared to 13.5% in south and 15% in North regions, respectively. Econometric analysis revealed that livestock, education and number of income earner positively affected on food security while family size and household heads' age have negative effect on food security. Timmer (2004) studied the duty of any government to speed up the growth which increases the food security and stabilizes the food prices. The strategic plan by central governments emphasis the satisfactory requirements for food security because it can promote trade and industry enlargement. In developing countries paradoxically especially rice-based economies of Asia the public access of food security quickly slips from its essential role as an economic encouragement.

Timmer (1980) explore the function of economic development with food security and food prices. According to Classical, food prices are not significantly impacts to the long term growth while neoclassical believes that food prices may be significant issue. This paper discusses different views on food prices and their effects in Indonesian economy and also debate the role of food prices in the policy procedure. Mariano & Giesecke (2014) explored the open economy inference and food security of three of the main policies. We check the effects of eliminating the plans of by using open economy model with complete management of farming

actions, land use, and food security measures and also locate plans which produce a small involvement to food security.

Wang (2010) empirically estimate the determinants of food security in which it is expressed as a function of different factors, cultivation adversity area, and food retail price index, and per capita disposal income, urban and rural areas saving. and sown area by using dynamic panel data analysis and sample of 27 provinces and time period is 1985–2007 in China and found climate change will affect the food security significantly in the current year. D'Souza & Jolliffe (2013) investigate the relationship between conflict in food prices and food insecurity in Afghanistan by using the survey data of nationally representative household. This survey data shows the dissimilarities and divergence in the food insecurity levels and prices all across the country. They used simple vicariate regression model of conflict on food security and find mixed associations.

2.2. Climate change and food security

Due to increase in rainfall and temperature in any country may have negative or insignificant effect on the areas with vast food creation? The regions that are already undernourished in the world can have shocking effect of climate instability. There is a negative impact of climate change on food exports in Australia and it represented that worldwide food security would be affected due to viable contribution to international trade in wheat, meat and dairy products of Australia Qureshi *et al.,* (2013). According to Ahmad *et al.,* (2011), climate change and food security are directly related to each other because any change in climatic aspect directly distress a country's capability to provide food to its people.

Demeke *et al.,* (2011) use a household survey in Ethiopia and find the impact of climate change factors and other economic factors on food security index. Ayinde *et al.* (2011) states that climate change variables rainfall and temperature both have positively effect on food production in Nigeria. Dell *et al.,* (2008) and Mendelsohn *et al.,* (2006) find that climate change or inconsistency in climate has negatively affected on economic growth in the developing countries.

According to (FAO, 2008) Climatic changes distress all the approaches of food security. By Greg *et al.*, (2011) Availability is directly affected by climate change through its impact on agricultural production and its effect on crop harvests and crop shells is negative. Stability is also negatively affected by climate change variables access and utilization may also affect by the variation in climate because it may decreases the actual nourishment of food and also growth the numerous health problems. So at the end we can say that climate change would become a serious problem for hunger, poverty and food insecurity in any country. By Schmidhuber & Tubiello, (2007) Economic growth of a country is also affected by climate change indirectly by its impact on money supply and cultivated demand. Gregory *et al.,* 2005; Rosegrant & Cline, 2003; Cline, 2007; Parry *et al.,* 2005 to achieve food security in poor countries is too much difficult as a result of climate change in any country. Climate change may also decreases the crop productivity attached with other problems such as growing population, scarcity in water accessibility and land deprivation. Furthermore, climate change is also linked to a decline in crop productivity and Pakistan is badly affected by this. Adjusting to climate change factors can shrink the destructive effect on farming production (Di Falco & Chavas, 2009).

Climate change is an important variable to be included in the food security model. Alam, Siwar. In the study of Murad & Toriman (2011) examine the issues about the climate change occurrences in Malaysia. Due to natural disasters, floods and pest attacks changing the crop cycle, agriculture productivity, choice of crops and food security in Malaysia.

Different studies that have cited above defined the impact of climatic variables on food security in different economies. But in Pakistan we find a few studies that focusing on the impacts of climatic change factors on food security empirically. Contribution of the present study is that it determines the impact of climate change

variable on all approaches of food security empirically. In the case of Pakistan, there is no comprehensive study on climate change and food security in Pakistan. At macroeconomic level, there are some issues that describe the complications of studying the effects of climate change and its impact on food security.

2.2.1. Climate change effect on food availability

Climate change directly effects the food production by the changes in natural conditions and indirectly affected the economic development, income and demand for cultivated crop. There is a direct effect of climate change on food availability because of the changes in temperature, rainfall and water supply. Availability of food indicates the physical presence of food or domestic production of food grain from agriculture or allied sector in a particular region or place in certain duration and with given technology inventory levels, local and international trade, commercial imports or food aid and this mainly focuses on food production (ADB, 2012). Changes in temperature and precipitation associated with continued emissions of greenhouse gases will bring changes in land suitability and crop yields (Schmidhuber & Tubiello, 2007).

2.2.2. Climate change effect on food stability

Stability of food has also affected by the changes in climatic factors because of increase in the regularity and cruelty of risky occasions such as storms, water scarcity, overflows, and famines bring greater variations in crops and it damage the food production. These climate change effects are a certain risk to the stability of food. The increasing in Weather conditions is expected to become more flexible than at present. More instability in harvests of crops and resident food stores can badly disturb the stability and food security in Pakistan. Mostly in sub-Saharan Africa and South Asia are the poorest regions with the maximum levels of continuing hunger will be visible to the uppermost degree of instability.

Mostly rural areas depends on rain water for crops production but the changes in the frequency, timing and quantity of rainfall inside the period and an increase in climate inconsistency are likely to worsen the instability of indigenous nourishment structures (FAO, 2008).

2.2.3. Climate change effect on food utilization

Food utilization also effected by climate change variables. This part of food security is usually narrates to dietary features of food intake. According to Rosenzweig & Binswanger in (1993) climate can form the choices to growers about what crops to cultivate. Climate change may initiate a vicious circle where infective illnesses, including water-borne diseases, cause or compound hunger, which in turn makes the affected population more susceptible to those diseases. Results may include declines in labor productivity, water scarcity and an increase in poverty, sickness and death.

2.2.4. Climate change effect on food accessibility

Access to food refers to the ability of individuals, communities and countries to purchase food in sufficient quantities and quality. Falling real prices for food and rising real incomes over the last 30 years have led to substantial improvements in access to food in many developing countries. Possible food price increases and declining rates of income growth resulting from climate change may reverse this trend.

3. Model Specification

The functional relationship of variables is given under.

Model 1. *Food security index = f (GDP, Area under cultivation, Mechanical inputs, Average Rainfall (mm per year), Population growth)*

Model 2. *Food production index = f (GDP, Road kilometers, Total water supply, Credit to agriculture sector, Biological and mechanical inputs, Food imports)*

In the first model we take food security index as dependent variable and in model 2 we take the proxy of food security food production index as dependent variable. There are some other variables that have slight effect in determining food security. We cannot include all those variables in our model that's why error term is used in econometric models which capture and also account for the effect of minor variables in analysis.

3.1. Construction of Food Security Index

Food security is a multifaceted and complex issue and it is affected by many economic, agricultural, climatic and infrastructural factors. Agriculture productivity of any country directly or indirectly affects the food security. Index means relating and summing many measures of a variable into a single score or variable. To identify the food security index we have studied different literature and follow z-scored method for the aggregation of all food security pillars equally for a country's prospective. This method was used by Shakeel *et al.,* (2012); and Rukhsana (2011) Ajay Kumar and Pritee Sharma, for India's prospective. Demeke *et al.,* (2011) alsousez-score method for constructing food security index and also investigate the impact of agricultural production and climatic factor on food security index, using primary survey of households in Ethiopia separate variables. Thismethod is based on the descriptive analysis and includes all the components of food security as availability, access, stability and utilization. All components of food security are equally important for measuring food security situation in a country. We have also follow Anand & Sen (1997), suggestion for choosing the power of all components. By using these methods we contain or combine all indicators of food security.

There are many types of indexes for generating index we must careful about every substances of an index. In this study descriptive analysis is used for creating food security index of a country Pakistan. This method is also used for constructing global food security index.

Food security index (FSI) can be calculated by the given below formula.

$$FSIs = \Sigma CIi/n$$

FSI states food security index, s denote to state and n is total number of parameters. By taking different indicators and combine all of them and create state wise index of food security.

In this method food security can be calculated by two ways either we can aggregate each dimension of food security it means rely on equal weighting means all variables have equal weight. The other way is to construct food security index by the aggregation of all dimensions because all are important for measuring food security of a country. Literature approves that by this method we can give greater or lesser weight of any dimension by giving the different power. The functional form of model is given below:

$$(FSI)\, t = \beta 0 + \beta 1\, (AVAF)\, t + \beta 2\, (STAF)\, t + \beta 3\, (ACCF)\, t + \beta 4\, (UTIF)\, t + \phi t$$

Where, *FSI* is food security index. *AVAF*, *STAF, UTIF* and *ACCF* are availability, stability, utilization and accessibility of food respectively t is time period respectively and $\beta 0$ is constant coefficient; and $\beta 1$, $\beta\, \theta 2$, and $\beta\, \theta 3$ are the regression coefficient for respective variables. Φis the error term in the model.

3.2. Econometric Model for Food Security Index

To find the Inter linkage between food security index and its components, simple multiple regression model is applied for time period, 1990 to 2014. Created food security index as a reaction function is degenerated with its components such as availability, stability accessibility and utilization of food. This study follows

Sen's suggestion to choose power = 3 as it places greater weight of all dimensions (Anand & Sen, 1997, p. 16).So we use weighted formula for constructing food security index of Pakistan. This given below formula used to compute the FIMI for a country. Given below formula is used to calculate food security index for Pakistan,

$$FSI= (1/4(AVi3 + ACi\ 3 + UT\ i3 + STi\ 3)\ 1/3$$

FSI is food security index. *AV,* AC*, UT* and *ST* are availability, accessibility, utilization and stability of food respectively. By using Sen's suggestion we give power 3 to all indicators of food security it means all measures of food security are equally weighted in this analysis. Summing all the measures of food security availability, accessibility, utilization and stability construct or generate food security index into a single measure of food security. And then we reduce the value of index by, selecting a base year and put it equal to 100 and then scale all the index accordingly.

3.3. Description of variables

Food security index

To find Food security index used z-score method and FIMI method of aggregation of all dimensions are used for a country it's also used by Anand & Sen, (1997) and this Z-score method is used by Shakeel *et al.,* (2012) and Rakshasa (2011) in India. By using these methods we contain or combine all indicators of food security such as availability, access, utilization and stability of food.

Most of the studies on food security in Pakistan measured food security as availability of food and used food production index as proxy of food security because availability is the most important pillar of food security. But no one used all indicators of food security for measuring food security in Pakistan. In this study we attempt to construct food security index of Pakistan by taking all indicators of food security and convert all indicators into a single value. So we can portion food security by taking all measures of food security. So question is which approach of food security is important for measuring food security?

In our model we can easily solve this problem. We converted all indicators of food security into single measure by generating food security by using idea of "FIMI (2011)". All measures of food security are important for measuring food security such as availability, access, utilization and stability of food. We follows Sen's suggestion to choose power = 3 as it places greater weight of all dimensions (Anand & Sen, 1997). So we use weighted formula for constructing food security index of Pakistan. We collect data on all indicators of food security from FAO (food agriculture organization) and World Bank Indicators.

Food production index

Food production index is the net production of agriculture sector of a country including all eatable products excluding coffee and tea. It covers also all crops production in Pakistan. Food production index is a measure of food security indicator availability. Availability of food is essential indicator of any food security model and it is only indicator for long time due to ultimate reason. In model 2 we take food production index as proxy of food security indicator availability and narrow down our research from all indicators to single important component of food security. Availability of food indicates the physical presence of food or domestic production of food grain from agriculture or allied sector in a particular region or place in certain duration and with given technology inventory levels, local and international trade, commercial imports or food aid and this mainly focuses on food production (ADB, 2012).

GDP

Real GDP is a measure of total output of Pakistan's economy. This variable is measured Economic growth and it has been considered as it's a most powerful engine that pulls the people out of the clutches of the poverty and raises their

standard of living. Variations in Gross Domestic Products also create the instabilities in the Employment level, food production, Price level of a country and many other economic factors. Food security is to be a great point pretentious by economic growth and income distribution. Economic growth and food security jointly strengthen each other in developing process in the present study we used GDP per capita as (constant 2000 US$). By Torero (2014), the UN Food and Agriculture Organization assume that increase in the rate of undernourished people it may also damage in gross domestic product (GDP) of as much as 4 to 5 percent per year. This variable shows the correspondence with food security in Pakistan. The use of GDP is consistent with previous literature using income as one of the factor that influences food security.

Population growth

Population growth variable is one of the major factors that affect the food security in Pakistan. Population growth have mixed effects on food security, but in general, it is expected to have a negative effect Thomas Malthus underwrites that population growth is another reason of food insecurity in Pakistan. The Malthusian "approach is focused on the (dis)equilibrium between population and food. According to Malthus (1992), population growth causes an increase in burden on agricultural resources. Increase in population is a major factor of food insecurity in developing countries such as Pakistan. In this study we use the variable population growth in our analysis.

Area under cultivation

Total area under cultivation is a key factor that impact on food security situation in Pakistan. Due to increase in population, cultivation area decreases by the population pressure in Pakistan and food insecurity situation also occur because of the insufficient food for growing population. According to literature the total population is doubled but the cultivated land 40% it cannot meet the food requirement of growing population. Total cultivated land is a constant variable and it was measures by hectare. Some of the literatures have considered total cultivated land is connected with food security Garrett & Ruel, (1999); Grootaert & Narayan, (2004). If cultivated land increases, the possibility that people get more output and less chances of food insecurity.

During the past 60 years, there was more than 4 times increase in population with urban growth of over seven-fold resulting into mega-cities as well as rising population pressure on cultivated land. Despite that wheat production a major food crop, has increased by five-fold the country is still marginal importer of wheat if a country has developed financial market. In the present study we see the relationship of this economic variable with food security.

Climate change

Due to change in climate food production decreases in Pakistan and prices are also rises due import food items. We have used rainfall as a proxy to measure the climate change in Pakistan**.** We collect monthly data on rainfall from world climate data center (WCDC) and metrological department and then take average of all data and convert data into yearly basis. Edame, *et al.,* (2011) examined the impact of climate change on major components of food security such as availability, accessibility, affordability, preference, utilization, and nutritional value and food system stability. Mee & Keong (2011) have estimated the economic impact of climate change on food security.

Mechanical and biological inputs

The use of technology and fertilizer in agriculture sector may contribute major change in food production. Uses of biological and mechanical inputs in production process cause the high food production in Pakistan. In this study we use number of tractors as proxy of mechanical inputs and use of fertilizer as proxy of biological inputs and determine its impact on food security in Pakistan. The use of fertilizer increases the total productivity of cultivated land. Increase in technological inputs like number of tractors and biological inputs like usage of fertilizers may increase in food production in developing countries such as Pakistan.

Food imports

Imports of different food is basically refers the food production of a country at national level. An increase in food imports of a country will divert the intention in the more production of import food for the requirement of growing population. Food imports are discouraging the domestic food producers, because food imports might be cheaper than the domestic production.

Road kilometers in Pakistan

A Road distance kilometer is a major infrastructural factor that effects food production in developing countries. A Road kilometer is actually proxy for farm market connectivity more the roads faster the food will reach to the market and more chances that it will be sold cheap and fresh.

Total water supply in Pakistan

A great amount of water is required for food production and food production is directly related to ensuring sufficient water. 1000 liters water is required for producing one kilogram wheat and rice. Water supply is also a climatic factor and mostly in rural area producers depends upon rain water for food production. Drinking water supply and agriculture sector water supplies in Pakistan faces many challenges due to high population growth. Poor quality drinking water causes major diseases more than 3 billion Pakistani infected by the water diseases in Pakistan every year.

Credit access to agriculture sector

Credit to agriculture sector is essential for production in Pakistan because food production is concerning farming productivity with formal credit and other independent variables including land and water. The expected effect of access to credit on food security is positive. Access to credit means enhancement in agriculture production and it will increase the income creating activities as well and also achieve food security. Credit to agriculture sector acts as an important contribution beside with modern machinery for advanced production. Credit requirement for agriculture will increase the productivity. There are some formal and informal sources of credit in Pakistan. Formal sources are ZTBL (Zaria Taraqiati bank limited) and Agricultural Development Bank of Pakistan (ADBP), Commercial Banks, and Federal Bank for Cooperatives. Recently, some non-government organizations (NGOs) are also advancing agricultural credit to the rural communities.

3.4. Sampling and Data Source

In model 1 there are 24 observations from 1980 to 2014 annually. Less number of observations is due to unavailability of data. In second model 41 observations from 1973 to 2014 we use food production index as proxy of food security. The data on rainfall is a proxy of climate change attain from "world climate data center (WCDC) and metrological department Islamabad. While the data on real GDP, population growth, area under cultivation, total water supply, credit to agriculture sector, road kilometers in Pakistan, food imports, biological and mechanical inputs are attained from WDI have been taken from Pakistan Economic Survey and Pakistan bureau of statistic (PBS). Data on food security index was collected from Food and Agriculture Organization (FAO). For constructing index of food security index we use all indicators data of food security and made index by the help of Sen's formula. Some other useful sources that are also visited for sample are international food policy research institute (IFPRI), metrological department Pakistan.

4. Results

In the above table all the p values are greater than 0.05 which depicts that the statistics of the data are normal. In descriptive statistics, we analyze the values of JarqueBera the value of variables have found to be insignificant it means all data series are normally distributed. The value of kurtosis and skewness are near to 3 and 0 which indicate the normality of data.

Table 1. *Model 1- Descriptive Statistics*

Variables	LFSI	FPI	LGDP	POP	RAINF	LTUEBWEL	LTRCTR	AGRILAND	TWS
Mean	12.3487	91.5525	1.40351	2.29297	23.3678	13.41302	10.26344	34.68913	131.540
Std. Dev.	0.165063	18.86980	0.58035	0.264726	4.58219	0.425945	0.620207	0.559986	6.09903
Skewness	0.36860	-0.0037	0.50155	0.74730	0.19644	-0.287580	-0.145248	-0.544099	-1.03220
Kurtosis	2.04473	1.799828	2.89505	2.348387	2.92397	1.628207	1.735854	1.941671	2.90932
Jarque-Bera	1.45601	1.44046	1.01724	2.65846	0.16014	2.212626	1.682452	2.304237	4.27002
Probability	0.48287	0.48663	0.60132	0.26468	0.92304	0.330776	0.431181	0.315967	0.11824
Sum	296.369	2197.260	33.6843	55.0314	560.827	321.9125	246.3225	832.5390	3156.96
Sum Sq. Dev.	0.62665	8189.59	7.74678	1.61184	482.919	4.172874	8.847095	7.212445	855.550
Observations	24	24	24	24	24	24	24	24	24

Stationary of data is also required for good analysis. There are four popular tests that can be applied to check unit root in data series. ADF, Phillips-Perron (PP), Ng-Perronand KPSS these all test are equally valid for unit root. These tests actually reports about integration order of variables. KPSS and Ng-Perron tests are often used for small sample size and these tests give more superior results. In this study we used all given tests. These tests give us same results that conclude order of integration is mixed. We find that some variables are found to be stationary at level and some are at 1st difference. So when we find I (0) and I(1) order of integration then we apply Auto Regressive Distributed Lag (ARDL). Output of unit root tests are given in Table.

Table 2. *Stationary by using ADF*

	With Intercept		With Intercept and trend	
Variables Name	T-value	P-value	T-value	P-value
LFSI	-3.049109	0.0458**	-4.962939	0.0638**
LGDP	-3.415191	0.0210*	-3.530119	0.0021*
RAINF	-3.722904	0.0107*	-3.756510	0.0385*
AGRILAND	-4.014998	0.0058**	-4.014678	0.0007**
LTRCTR	-4.542588	0.0023**	-3.319970	0.0947*
POP	-2.696078	0.0913*	-6.991775	0.0001**

Notes: Where; the sign * indicates variable is stationary at level and ** shows variable stationary at 1st difference .Here LGDP, Rain Fall and Population are I (o) and all other variables are I (1)

4.1. Auto Regressive Distributed Lagged Model Approach (ARDL)

Outcome of unit root tests shows all variables have different order to integration I(1) and I(0) so we will apply ARDL because of OLS is best if all variables are I(0) and Johansen & Juselius (1990) and Johansen (1998,1991) can be applied in case of only I(1).

4.2. Optimal Lag Length

After checking the stationary of series, we have to see optimal lag length. Optimal lag length indicates that how many lag should be use in model. The results of above table shows four lag should be used in model.

Table 3. *Optimal Lag Length*

Lag	*LogL*	*LR*	*FPE*	*AIC*	*SC*	*HQ*
0	-21.92365	NA	2.00e-08	2.157383	2.572154	2.227280
1	92.23331	155.9415*	1.75e-10*	-2.589512*	0.004717*	-1.876986*

Notes: * indicates lag order selected by the criterion; LR: sequential modified LR test statistic (each test at 5% level); FPE: Final prediction error; AIC: Akaike information criterion; SC: Schwarz information criterion; HQ: Hannan-Quinn information criterion.

We select optimal lag for our model on the basis of lowest value of H-Q Criterion. After selecting lag length criteria, we evaluate long term dynamics of variables under consideration.

Table 4. *Outcome of ARDL Approach, ARDL Bounds Testing Approach*

Estimated Models				
Optimal lags			(1,1,0,1,0,0)	
Statistics for W			24.6092 *	
Statistics for F			4.8349 *	
Significance Level	Critical Bounds For F– Statistics		Critical Bounds For W – Statistics	
	Lower Critical Bound	Upper Critical Bound	Lower Critical Bound	Upper Critical Bound
5 per cent	3.4088	4.9081	20.4527	29.4486
10 per cent	2.7484	4.0364	16.4905	24.2185
DIAGNOSTIC TESTS				
Serial Correlation	0.23276[.629]		R^2	0.93
Functional Form	.072433[.788]		Adjusted - R^2	0.90
Normality	2.2776[.320]		F – Statistics	26.11[.000]
Heteroscedasticity	2.0000[.157]		DW – Statistic	1.78

Notes: Asterisks are the indication of significance of values, ***, **, and *, and show significance a 1%; 5% and 10% levels respectively. The Probability Values are given in { } brackets

After lag length criteria, now we are going to see the long run relationship among food security index and its determinants by using latest co-integration approach. As the null hypothesis of the test state that there is "No co-integration" and it is only rejected if calculated value of F- statistics is higher than upper critical bound value. The above Table reveals that the calculated value of F-statistics higher than its upper critical bound at 10% level of significance: 4.8349 > 4.0364 so then null hypothesis is rejected and alternative hypothesis has been accepted and value of W- statistics is also higher than its upper critical Bound at 10% level of significance: 24.6092 > 24.2185. It means the model has long-run relationship in other words food security index has stable and long run link with independent variables. The diagnostics reveal that there is no problem with Heteroscedasticity and the error term is normally distributed. Serial correlation and the functional form of three models are also correct.

4.3. Long Run and Short Run Dynamics

ARDL (1, 1, 0, 1, 0, 0) selected based on Schwarz Bayesian Criterion is dependent variable, while, are independent variables. Long run and short run results are given below.

Table 5. *Short Run Dynamics*

Error Correction Representation for the Selected ARDL Model			
Dependent Variable:			
Name of Variable		Coefficient	P-value
		-.018958	-.97794[.343]
LFSI		-.27983	-2.1109[.051]
LGDP		.0034495	1.3404[.199]
RAINF		-.048586	-1.5650[.137]
AGRILAND		.034564	.63428[.535]
LTRCTR		-.54470	-3.6435[.002]
POP			
R-squared	0.60	Mean Dependent Variable	.013043
Adjusted R-squared	0.38	S.D. Dependent Variable	.063920
S.E. of Regression	.050154	Akaike Information Criterion	32.9045
Sum Squared Residual	.035216	Schwarz Bayesian Criterion	27.7947
Log Likelihood	41.9045	Durbin-Watson Stat	1.7821
F-statistic	3.6223	Prob. Value (F-statistic)	[.018]

Notes: *; **, and *** reveals significance level of test statistic at 10%, 5% and 1% respectively.

ARDL (1, 1, 0, 1, 0, 0) selected based on Schwarz Bayesian Criterion

Tablo 6. *Long Run Results of ARDL*

	Dependent Variable:	
Name of Variable	*Coefficient*	*P-value*
LFSI	-.10196	-2.0496[.060]*
LGDP	-.51374	-1.8476[.086]*
RAINF	.019068	3.0889[.008]**
AGRILAND	-.089197	-1.4111[.180]
LTRCTR	.063454	.70155[.494]
POP	15.6771	4.5694[.000]

Notes: The P-values with * are significant at 10 % level and values with ** are significant at 5% level.

The above results show that coefficient of rainfall of is positively related to food security index and its impact on food security is statistically significant. Positive sign of rainfall shows that rainfall at other period positively affected but at the time of harvesting crops its affect is negative at different regions. And the magnitude of the coefficient shows that one percent change in rainfall will increase food security by 0.1906 percent. So as the magnitude of coefficient is strong it would have more influence on food security index. Our results match with Ayinde *et al.* (2011) Demeke *et al.* (2011) Wang (2010) Aker & Lemtouni (1999). The other variable i.e. population is also statistically significant and has a negative impact on food security. In Pakistan population growth rate is very high and its effects on food security are negatively related. The magnitude of coefficient can be interpreted as one percent change in population growth will decrease food security by 0.513 percent in Pakistan see for instance (Malthus 1992; Wang 2010; Timmer 1980; Boserup 1965 and Boko *et al.,* 2007).

The coefficient of GDP is negative but statistically significant. In Pakistan food insecurity rate is very high that's why economic growth of Pakistan is negatively affected. The magnitude of coefficient is very small as it can be interpreted as one percent change in GDP will impact food insecurity by 0.1 percent. However economic growth of developing countries influences by the food insecurity. There are number of studies that support this negative relationship see for instance (Dell *et al.,* 2008; Mendelsohn *et al.,* 2006; Wang; 2010; Timmer, 1980; Boserup, 1965 and Boko *et al.,* 2007). According to Torero (2014), the UN Food and Agriculture Organization assume that increase in the rate of undernourished people it may also damage in gross domestic product (GDP) of as much as 4 to 5 percent per year.

The coefficient of technology is positive and statistically significant. We can interpret as one percent increase in technology will increase the Food security by .063 percent. In other words we can say country with more advance method of farming like increase the number of tractors and tube wells, possibility to secure more food for growing population. In case of Pakistan old methods of farming used for cultivation that's why food insecurity issue exists. Literature suggests if country uses more advance technology it will increase the food security as well as increase the economic growth of the country. Pakistan is a developing country and it has not enough resources to make more advance technical inputs to increase agriculture production in Pakistan.

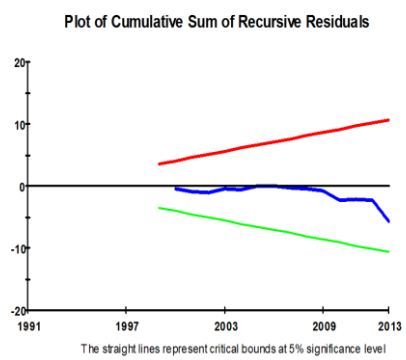
The coefficient of agriculture land/cultivation land is negative in our case but statistically insignificant. In Pakistan population growth rate is very high and its effects on cultivation land and food security are negatively related because agriculture land cannot fulfill the food requirement of growing population in Pakistan. The magnitude of coefficient can be interpreted as one percent change in agriculture land .089 percent towards food security in Pakistan. According to literature total population is doubled but the cultivated land40% it cannot meet the food requirement of growing population. However agriculture land ratios influences the food security in developing countries. There are number of studies that support this negative relationship see (Mendelsohn *et al.,* 2006).

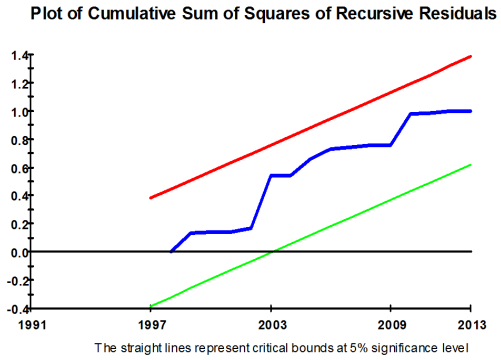
In the above table R-square value is 0.67 which shows that our model is moderate fit for the analysis. The DW value is 1.7 which is within the tolerance level and we can say that there is no auto-correlation in our model.

4.4. Diagnostics for CUSM and CUSUM Square

Stability test

Stability of long run coefficient has been shown with the help of cumulative sum of recursive residuals (CUSUM) of cumulative sum of squares recursive residuals (CUSUM SQUARE) test.





The diagnostics of CUSUM and CUSUM squares confirm the stability of our model. The above figures (6.1 and 6.2) show stability at 5 percent level. Here we are satisfied with the CUSUM and CUSUM squares because estimated lines are in the given limit of upper and lower critical lines. On the other hand if estimated lines positioned out of critical bounds then our model is not stable. So, now it is clear graphically that there exist long run and stable link between food security index and its determinants that are used in this study. We can conclude as; food security index is sure for Pakistan over the estimated period. In other words, there is no structural break in model policy maker can use it for policy options.

4.5. Measure food security as availability component;

Data series should be normally distributed in the first step of econometric analysis. In descriptive statistics, we check the values of JarqueBera test; the value of variables has found to be insignificant it means all data series are normally distributed.

Table 7. *Model 2 - Descriptive Statistic*

Variables	FPI	TWS	LBIOL	LGDP	LCAS	LFIMP	LTRC	LRKP
Mean	71.10732	117.0146	12.92897	10.54671	9.900323	2.715881	10.01627	11.58203
Std. Dev.	28.27669	19.81017	0.721912	0.271218	1.848961	0.279632	0.728785	0.846045
Skewness	0.159255	-0.527908	-0.012318	-0.289155	-0.183307	0.324639	-0.145248	-0.092894
Kurtosis	1.663863	1.771785	1.601217	1.886718	2.274800	2.481078	1.735854	1.255678
Jarque-Bera	3.223132	4.481403	3.343551	2.688640	1.128047	1.180190	11.74511	5.256841
Probability	0.199575	0.106384	0.187913	0.260717	0.568915	0.554275	0.431181	0.072192
Sum	2915.400	4797.600	530.0877	432.4151	405.9132	111.3511	410.6670	474.8632
Sum Sq. Dev.	31982.85	15697.71	20.84626	2.942361	136.7463	3.127762	21.24511	28.63171
Observations	41	41	41	41	41	41	41	41

The estimated values of Kurtosis and Skewness indicate that data is normal. Stationary of data is also required for good analysis. There are four popular tests that can be applied to check unit root in data series. ADF, Phillips-Perron (PP), Ng-Perron and KPSS these all test are equally valid for unit root. These tests reports about integration order of variables. KPSS and Ng-Perron tests are often used for small sample size and these tests give more superior results. In our study we use ADF test. These tests give us same results that conclude that order of integration is mixed. We find that some variables are found to be stationary at level and some are at 1st difference. So when we find I (0) and I (1) order of integration then we apply Auto Regressive Distributed Lag (ARDL). Output of unit root tests are given in appendix.

Table 8. *Statistics of ADF*

Name of Variables	Intercept		Intercept & Trend	
	t-Stat	Prob.	t-Stat	Prob.
FPI	-5.841488**	0.0000	-5.895668**	0.0001
TWS	-4.913020**	0.0003	-4.994559**	0.0012
LBIOL	-4.957280**	0.0002	-5.242212*	0.0006
LGDP	-9.087338*	0.0000	-10.18124**	0.0000
LCAS	-8.420254**	0.0000	-8.178662**	0.000
LFIMP	-4.065941*	0.0029	-4.039901*	0.0149
LTRC	-3.333364*	0.0200	-5.144743*	0.0025
LRKP	-5.968391**	0.0000	-5.890628**	0.0001

Note: * is indication of having stationary on level and ** indicates having stationary on first difference. Where; the sign * indicates variable is stationary at level and ** shows variable stationary at 1st difference.

4.6. Auto Regressive Distributed Lagged Model Approach (ARDL)

Outcome of unit root tests shows all variables have different order to integration I(1) and I(0) so we will apply ARDL because of OLS is best if all variables are I(0) and Johansen & Juselius (1990) and Johansen (1998,1991) can be applied in case of only I(1).

According to the above results we select Akaika information criteria for optimal lag lengths and we know how AIC picked these lags. There are many models but the above table shows the top 20 models result so we select first model of ARDL (3, 2, 2, 3, 2, 0, 3, 2). After selecting lag length criteria, we evaluate long term dynamics of variables under consideration. You can also get the full summary of the AIC, SC, Hannan-Quinn, and adjusted R^2 statistics for all models if we select criteria table rather than graph.

Table 9. *Outcome of ARDL Approach - ARDL Bounds test to know about long run relation*

Estimated Models			
Optimal lags			(3, 2, 2, 3, 2, 0, 3, 2)
Statistics for F			3.8519*
Critical Bounds For F– Statistics			
Significance	Lower Critical Bound		Upper Critical Bound
10%	2.03		3.13
5%	2.32		3.5
2.5%	2.6		3.84
1%	2.96		4.26
DIAGNOSTIC TESTS			
Serial Correlation	3.25339{.101}	R^2	0.8735
Functional Form	0.42567{.528}	Adjusted - R^2	0.5975
Heteroscedasticity	1.2870{.340}	DW – Statistic	2.6519

Note: Asterisks are the indication of significance of values, ***, **, and *, and show significance at 1%; 5% and 10% levels respectively. The Probability Values are given in { } brackets

After lag length criteria, now we are going to investigate long run relationship among food production index and its determinants by using latest co-integration approach. As the null hypothesis of the test state that there is "No co-integration" and it is rejected if calculated value of F- statistics is higher than upper critical bound value. The above Table reveals that the calculated value of F-statistics higher than its upper critical bound at 5% level of significance: 3.85196 > 3.5 so then null hypothesis is rejected and alternative hypothesis has been accepted .It means the model has long-run relationship in other words we can say that food production index has stable and long run link with independent variables. The diagnostics reveal that there is no problem of Heteroscedasticity and the error term is normally distributed. Serial correlation and the functional form of three models are also correct.

4.7. Long Run and Short Run Dynamics

ARDL (3, 2, 2, 3, 2, 0, 3, 2) selected based on Akaika Information Criteria is dependent variable, while are independent variables. Long run and short run results are given. The long run results which are estimated through ARDL bound testing

approach are shown in the above table. The above results show that the coefficient of GDP has positive and significant impact on food production index. The coefficient is interpreted as one percent change in GDP of Pakistan will increase food security by 1.8 percent. However economic growth of developing countries is influenced by the food insecurity. There are number of studies that support this positive relationship like Dell *et al.,* (2008) and Mendelsohn *et al.,* (2006) Wang (2010). The coefficient of Road kilometers in Pakistan has positive and significant effect on food production index. We can interpret as one percent decreases in kilometers it will be more the food production 0.13256 percent. Road kilometers are actually proxy for farm market connectivity more the roads faster the food will reach to the market and more chances that it will be sold cheap and fresh.

Table 10. *Long Run and Short Run Dynamics*

Estimated Long Term Coefficients using the ARDL Approach			Error Correction Representation for the Selected ARDL Model		
Dependent Variable:			Dependent Variable:		
Name of Variable	Coefficient	P-value	Name of Variable	Coefficient	P-value
FPI	1.8083*	0.0049	FPI	0.1120	0.849
TWS	0.217422*	0.0106	TWS	-0.1035	0.534
LBIOL	-0.22809**	0.0231	LBIOL	-0.0004	0.995
LGDP	0.06846**	0.7951	LGDP	0.74652**	0.031
LCAS	0.13256 *	0.0095	LCAS	0.18684*	0.013
LFIMP	0.15220**	0.0369	LFIMP	-0.0786	0.326
LTRC	0.00410	0.9483	LTRC	0.13580**	0.064
LRKP	-18.8654	0.0021	LRKP	-1.4094	0.004

Diagnostics for ECM			
R-squared	0.873510	Mean Dependent Variable	0.026203
Adjusted R-squared	0.597533	S.D. Dependent Variable	0.048646
S.E. of Regression	0.030861	Akaike Information Criterion	-3.915381
Sum Squared Residual	0.010476	Schwarz Bayesian Criterion	-2.815715
Log Likelihood	95.47685	Durbin-Watson Stat	2.651984
F-statistic	3.165148	Prob. Value (F-statistic)	0.000000***

Note: *; **, and *** reveals significance level of test statistic at 10%, 5% and 1% respectively.

The coefficients of biological and mechanical inputs are positive and statistically significant. We can interpret as one percent increase in number of tractors will increase the Food production by 0.1522 percent and increase in fertilizer usage will increase the production 0.2174 percent. In other words we can say country with more advance method of farming like increase the number of tractors, tube wells and biological inputs will increase the possibility to secure more food for growing population. In case of Pakistan old methods of farming used for cultivation that's why food insecurity issue exists. Literature suggests if country uses more advance technology it will increase the food security as well as increase the economic growth of the country. Pakistan is a developing country and it has not enough resources to make more advance technical inputs to increase agriculture production in Pakistan.

The findings disclose that the coefficient of food imports is positive it means that government is successfully filling the gap of food supply and food demand assuming that food imports are expensive as compared to domestic food production. The credit to agriculture sector has negative and significant effect on food production. Coefficient indicates that one percent increase in credit to agriculture sector strength the food production by 0.22 percent. The coefficient of Total water supply to the food production index is negative but statistically insignificant. In Pakistan people have not access even clean drinking water and sanitation facilities. Farmers face a lot of problems in food production due to scarcity of water. The size of coefficient is also very small it can be interpreted as one percent change in water supply in agriculture sector can change 0.228

In short run our main focus is value of ECM which is significant and negative as required. These three variables, and are significant in short run. The coefficient authenticate that 40 percent of the divergence will be converge to equilibrium in one year. The value of R square is 0.87351 in long run result which indicates our independent variables are able to explain 87 percent variation in dependent

variable. In other sense we can interpret as the weightage of our independent variables is 87 percent to choose food production index under agricultural sector of Pakistan.

Table 11. *Robustness check of model 1*

Variables	Model 1	Model 2	Model 3	Model 4	Model 5
LFSI	-.018958	-.070457	-.024893	-.072217	-.016796
LGDP	-.27983	.0053917	.22115	.037602	-.33864
RAINF	.0034495	.0083428	.0021385	.0079794	.0031669
AGRILAND	-.048586	-.044640	-.032441	-.066328	-.057835
LTRCTR	.034564	.037743	.028154	------	------
POP				.6902	
t		.30610	-.17309	.32788	
R2	0.93	0.93	0.94	0.39	0.93
DW	1.78	1.87	1.64	2.26	1.71
ECM(-1)	-0.54	-0.65	-0.94	-1.68	-0.48

Above table give us results of five regression models and in first model only two variables are significant and in model no two three variables are significant. Total water supply is used in model four but it remains insignificant. In model 4 and 5 we drop variable of and include remain significant so our results are robust. The diagnostics are also satisfied in all models.

5.Conclusion and policy Recommendation

This study has empirically analyzed the dynamic relationship between food security and selected macroeconomic variables (Pakistan's GDP, food imports, credit access to agriculture sector, rainfall, population growth in Pakistan, roads kilometers in Pakistan, agriculture land, biological and mechanical inputs, water availability) in Pakistan by using ARDL approach.

In our study we developed an index of food security for Pakistan by using all components of food security. Empirical findings of this study suggested that climate change, rainfall and technology have a significant positive impact on food security. On the other hand population and agriculture land entered the equation with negative signs. Our results are quite analogous to Demeke *et al.,* (2011) because his study also constructed an index for measuring food security and also investigate its linkages with climate change and socio economic factors.

Moreover, if the roads are faster, than the food will reach to the market on time and more chances that it will be sold cheap and fresh. Economic variables GDP is positively related to food security which can be beneficial for a country. Food imports entered the equation with positive sign which mean that government is successfully filling the gap of food supply and food demand assuming that food imports are expensive as compared to domestic food production on the other hand credit to agriculture sector entered the equation with negative sign.

Our results are important for economic policies. An important step to reduce food insecurity would be to raise the purchasing power of the severely food insecure people. In order to be effective at reducing the negative consequences of price volatility, targeted safety-net mechanisms must be designed. In line with this, promoting measures that enhance the food production system thereby increasing the capacity to fulfill the dietary requirements of people is imperative. One approach would be to invest in agricultural research, extension, and methods for reducing food production losses related to climate variability. Investment to create a more productive and efficient agriculture sector will make food more affordable for the poor and reduce price volatility as well. Careful consideration should be given to major investments in infrastructure to support irrigation and water resources development in order to limit the effects of food production reduction.

The findings of this study also suggest that the need for the policy makers to expend more on government spending and rural development in Pakistan. It will encourage and enhance the agricultural development especially for food production in Pakistan.

Appendix

Physical availability of food	Food availability addresses the "supply side" of food security and is determined by the level of food production, stock levels and net trade (Export-Import).
Economic and Physical Access to food	An adequate supply of food at the national or international level does not in itself guarantee household level food security. Concerns about insufficient food have resulted in a greater policy focus on incomes, expenditure, markets and prices in achieving food security objectives.
Food Utilization	Utilization is commonly understood as the way the body makes the most of various nutrients in the food. Sufficient energy and nutrient intake by individuals is the result of good care and feeding practices, food preparation, and diversity of the diet and intra-household distribution of food. Combined with good biological utilization of food consumed, this determines the nutritional status of individuals.
Stability of the other three dimensions over time	Even if food intake is adequate today, it is still considered to be food insecure if there is inadequate access to food on a periodic basis due to adverse weather conditions, political instability or economic factors (unemployment, rising food prices).

Availability of food means the physical incidence of food in a specific region or place for positive period of time and with given record levels, local and international trade, profitable significances, or food assistance. Availability is not just quantity of food it also discussed the diversity and quality of food stuff. According to Dev and Sharma (2010) and Shakeel et al (2012) availability of food for intake in a particular time period and locale. Moreover complete national supply is also considered as food security.

Access means all the people have physical and economic access of food all the time. Due to poverty and lack of development FAO in 1983 added this factor. This factor is the most important factor of food security because it can prevent hunger. This approach of food security is directly related with a population's economic capability to afford the food desirable for their endurance. Both availability and access are interlinked with each other.

Food stability states that food is available regularly in uncertain circumstances and sometimes available in the domestic market. Stability is about the assurance of food all time. Food insecurity may also be the result of short term or temporary shocks due to the climate change and rising prices of food stuff. When prices rise, it is the poor who are most at risk because they spend a much higher portion of their income on food. At the time of usual shock like overflows and scarcities also emphases specifically on the steadiness of supply and demand of food grain product (FAO, 2009).

Food Utilization means the safety, quality and nourishment of available food. Utilization of food is generally connected with food nutritious importance and the contact of physical form and food security. It can also describe as a household's ability to fascinate and absorb the nutrients, and the capability of people's bodies to use those nutrients efficient.

References

Aker, J., & Lemtouni, A. (1999). Un marco para evaluar la seguridadalimentaria de cara a la globalización: El caso de Marruecos. Revistaagroalimentaria, 5(8), 13-26.

Alexandratos, N. (1995). *World agriculture: towards 2010: an FAO study*. Food & Agriculture Org.

Ayinde, O., & Muchie, M. (2011). Effect of climate change on agricultural productivity in Nigeria: A co-integration model approach. *Journal of Human Ecology*, 35(3). 189-194.

Applanaidu, S.D., & Baharudin, A.H. (2014). An econometric analysis of food security and related macroeconomic variables in Malaysia: A vector autoregressive approach (VAR). *UMK Procedia*, 1, 93-102. doi. 10.1016/j.umkpro.2014.07.012

Ahmed, A., dam E.Abdelsalam, SawsanM.Siddig, Khalid H.A. (2012). Do grain reserves necessarily contribute to prices stability and food security in Sudan? An assessment. *Journal of the Saudi Society of Agricultural Sciences*, 11(2), 143-148. doi. 10.1016/j.jssas.2012.03.002

Asian Development Bank ADB, (2012). Food security and poverty in Asia and the pacific: Key challenge and policy issues, Mandaluyong City, Philippines. [Retrieved from].

Bashir, M.K., & Schilizzi, S. (2013). How disaggregated should information be for a sound food security policy?. *Food security*, 5(4), 551-563. doi. 10.1007/s12571-013-0271-y

Belloumi, M. (2014). *Investigating the impact of climate change on agricultural production in eastern and southern African countries*, Vol. 3. Intl Food Policy Res Inst. doi. 10.13140/2.1.3387.0727

Binswanger, H.P., Khandker, S.R., & Rosenzweig, M.R. (1993). How infrastructure and financial institutions affect agricultural output and investment in India. *Journal of development Economics*, 41(2), 337-366. doi. 10.1016/0304-3878(93)90062-R

Clay, E. (2002). Food security: concepts and measurement. Trade reforms and food security: Conceptualising the linkages. [Retrieved from].

D'Souza, A., & Jolliffe, D. (2013). Conflict, food price shocks, and food insecurity: The experience of Afghan households. *Food Policy*, 42, 32-47. doi. 10.1016/j.foodpol.2013.06.007

Demeke, A.B., Keil, A., & Zeller, M. (2011). Using panel data to estimate the effect of rainfall shocks on smallholders food security and vulnerability in rural Ethiopia. *Climatic Change*, 108(1-2), 185-206. doi. 10.1007/s10584-010-9994-3

Dev, S.M., & Sharma, A.N. (2010). Food security in India: Performance, challenges and policies. [Retrieved from].

Devereux, S. (2001). Sen's entitlement approach: Critiques and counter-critiques. *Oxford Development Studies*, 29(3), 245-263. doi. 10.1080/13600810120088859

Ehrlich, I., & Lui, F. (1997). The problem of population and growth: a review of the literature from Malthus to contemporary models of endogenous population and endogenous growth. *Journal of Economic Dynamics and Control*, 21(1), 205-242. doi. 10.1016/0165-1889(95)00930-2

Ehrlich, P.R., Ehrlich, A.H., & Daily, G.C. (1993). Food security, population and environment. *Population and Development Review*, 19(1), 1-32.

FAO, (2010). The state of food insecurity in the World: addressing food insecurity in protracted crises. Food and Agriculture Organization of the United Nations, Rome. [Retrieved from].

FAO, (2013). The state of food insecurity in the World: The multiple dimensions of food security. Food and Agriculture Organization of the United Nations, Rome. [Retrieved from].

FAO (2011a). Country rank in the World, by commodity. Food and Agriculture Organization of United Nations, Statistics Division.

FAO, (2011b). Food balance sheets. Food and Agriculture Organization of United Nations, Statistics Division. [Retrieved from].

Felix, B., & Romuald, K.S. (2009). Do Climatic shocks matter for Food Security in Developing Countries? [Retrieved from].

Felix, B., & Romuald, K.S. (2012). Rainfall Shocks, Food Prices Vulnerability and Food Security: Evidence for Sub-Saharan African Countries. [Retrieved from].

Fisheries, F.A.O. (2011). Aquaculture Department. 2013. *Global Aquaculture Production Statistics for the year*.

Foley, J.A., DeFries, R., Asner, G.P., Barford, C., Bonan, G., Carpenter, S.R., ... & Helkowski, J.H. (2005). Global consequences of land use. S*cience*, 309(5734), 570-574. doi. 10.1126/science.1111772

Fullbrook, D. (2010). Food as security. *Food Security*, 2(1), 5-20.

Gore, C. (1993). Entitlement relations and 'unruly'social practices: a comment on the work of Amartya Sen. *The Journal of development Studies*, 29(3), 429-460. doi. 10.1080/00220389308422283

Hanif, M.N.(2012). A note on food inflation in Pakistan. *Pakistan Economic and Social Review*, 50(2), 183-206.

Jolliffe, D., & D'Souza A. (2012). Conflit, food price shocks, and food insecurity: The experience of Afghan households, *Food Policy*, 42, 32-47. doi. 10.1016/j.foodpol.2013.06.007

Khan, R.E.A., & Gill, A.R. (2010). Determinants of inflation: A case of Pakistan (1970-2007). *Journal of Economics*, 1(1), 45-51.

Kumar, A., & Sharma, P. (2013). Impact of climate variation on agricultural productivity and food security in rural India. *Economics Discussion Papers*, No.2013-43.

Mariano, M.J.M., & Giesecke, J.A. (2014). The macroeconomic and food security implications of price interventions in the Philippine rice market. *Economic Modelling*, 37(C), 350-361. doi. 10.1016/j.econmod.2013.11.025

Maxwell, S., & Smith, M. (1992). Household food security: a conceptual review. *Household Food Security: concepts, indicators, measurements. Edited by S. Maxwell and T. Frankenberger. Rome and New York: IFAD and UNICEF*. [Retrieved from].

MacFarquhar, N. (2011). Food prices worldwide hit record levels, fueled by uncertainty, U.N. [Retrieved from].

Maxwell, S. (1996). Food security: a post-modern perspective. *Food Policy*. 21(2), 155-170. doi. 10.1016/0306-9192(95)00074-7

Mendelsohn, R., Dinar, A., & Williams, L. (2006). The distributional impact of climate change on rich and poor countries. *Environment and Development Economics*, 11(2), 159-178. doi. 10.1017/S1355770X05002755

Pandey, A. (2015). Food security in India and States: key challenges and policy option. Journal of Agricultural Economics and Rural Development, 2(1), 12-21.

Pinstrup-Andersen, P. (2009). Food security: definition and measurement. *Food security*, 1(1), 5-7. doi. 10.1007/s12571-008-0002-y

Qureshi, M.E., Hanjra, M.A., & Ward, J. (2013). Impact of water scarcity in Australia on global food security in an era of climate change. *Food Policy*, 38, 136-145. doi. 10.1016/j.foodpol.2012.11.003

Roderick, M.L., & Farquhar, G.D. (2011). A simple framework for relating variations in runoff to variations in climatic conditions and catchment properties. *Water Resources Research*, 47(12), doi. 10.1029/2010WR009826

Schmidhuber, J., & Tubiello, F.N. (2007). Global food security under climate change. *Proceedings of the National Academy of Sciences*, 104(50), 19703-19708. doi. 10.1073/pnas.0701976104

Schwab, K., & Sala-i-Martin, X. (2011). *The Global Competitiveness Report 2011-2012*. Geneva: World Economic Forum. [Retrieved from].

Shriar, A.J. (2000). Agricultural intensity and its measurement in frontier regions. *Agroforestry Systems*, 49(3), 301-318. doi. 10.1023/A:1006316131781

Timmer, C.P. (2004). Food Security and Economic Growth: An Asian Perspective Center for Global development, *Working Paper*, No.51. [Retrieved from].

Timmer, C.P. (1980). Food prices and food policy analysis in LDCs. *Food Policy*, 5(3), 188-199.

Wang, J. (2010). Food Security, Food Prices and Climate Change in China: a Dynamic Panel Data Analysis Agriculture and Agricultural Science, *Procedia International Conference on Agricultural Risk and Food Security 2010* , Vol.1, 321–324. doi. 10.1016/j.aaspro.2010.09.040

Wisser, D., Frolking, S., Douglas, E.M., Fekete, B.M., Vörösmarty, C.J., & Schumann, A.H. (2008). Global irrigation water demand: Variability and uncertainties arising from agricultural and climate data sets. *Geophysical Research Letters*, 35(24), doi. 10.1029/2008GL035296

WB, (2012). *Gross Domestic Product 2012, PPP*. World Development Indicators database, World Bank. [Retrieved from].

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